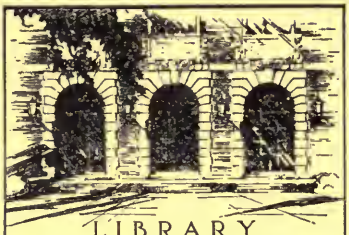

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What Determines

SOYBEAN PRICES

By G. L. JORDAN

Bulletin 546

UNIVERSITY OF ILLINOIS
AGRICULTURAL EXPERIMENT STATION

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Urbana, Illinois March, 1951

Publications in the Bulletin series report the results of investigations made or sponsored by the Experiment Station

WHAT DETERMINES SOYBEAN PRICES

By G. L. JORDAN, Professor of Agricultural Economics

THE PRICE which farmers receive for soybeans in peacetimes is determined by several factors, including: (1) the price users will pay processors for soybean oil; (2) the price users will pay processors for soybean meal; (3) the processing margin, or the amount that processors are able to obtain for their services; and (4) transportation and other handling costs on beans and products. *This analysis assumes no effective price supports and no effective price ceilings.*

One fact that makes the analysis of soybean prices so complicated is that there are several substitutes for both the oil and the meal. Users are interested in a number of edible fats and oils, not just soybean oil, and they are interested in a number of protein supplements for livestock feeding, not just soybean meal. On both the demand and the supply sides we must therefore consider *total available edible fats and oils* and *total available protein supplements.* While soybean oil can be used as a drying oil, and is so used when price relationships justify it, there are other drying oils that compete with it, so that the demand for it for this purpose is not large and we can ignore it. We can also forget nonfeed uses of soybean meal, as feed use sets the price and only small amounts are used for nonfeed purposes.

We shall see how the prices of soybean oil and soybean meal are determined, then note the relation of soybean prices to prices of soybean oil and soybean meal. Some consideration will also be given to the seasonal movement of soybean prices. It is recognized that a large number of forces affect prices of soybeans and that these forces vary in degree of influence over a period of time. It is also recognized that the period since soybeans have become a major crop and since the end of World War II, with all its disturbances to economic relationships, is so short that the relationships shown in this study may very well change during the next few years. The post-World War II period has been characterized by inflationary pressures, abnormally large consumer buying power in this country, exports facilitated by United States financing of importing countries, and disruption of world trade in fats and oils. These have all influenced soybean prices.

Soybean Meal Prices

We shall first examine the factors which affect the prices of soybean meal. It is a commonplace that in a freely competitive economy supply and demand determine prices. In the absence of free competition, dependence is placed on arbitrary decisions made by some person or agency regarding the supplies that will reach the consumers or the prices which may be charged. This latter condition prevailed during World War II; therefore the years 1942-43 to 1945-46 are ignored in this study.

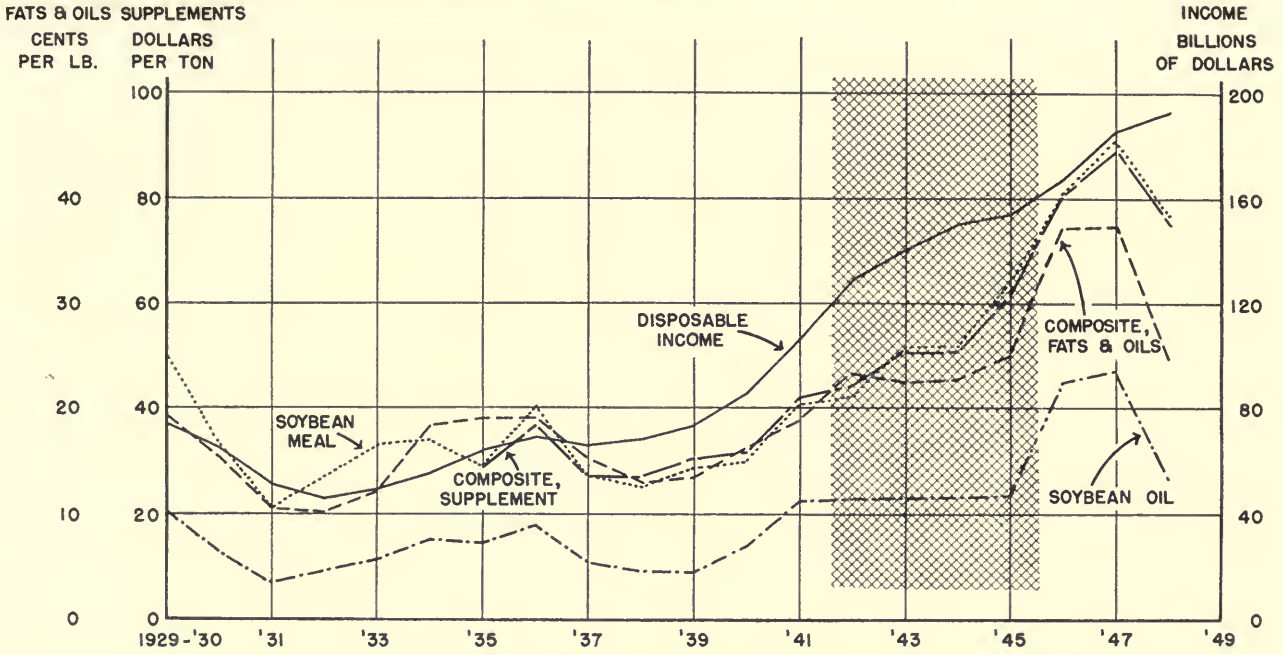
But we have to have some measures of demand and supply. In laymen's language, *demand* refers to both the ability and the willingness to buy. *Supply* refers to the total quantity which people are willing to sell. Obviously a person's ability and willingness to buy is related to his financial resources, and for most people that means their current income after taxes. Disposable personal income will therefore be used in this study as a measure of domestic demand.

The demand for meal is derived from the demand for meats and livestock products for the production of which the meal is used, and the demand for oil is derived largely from the demand for margarine and shortenings. The principal use of soybean meal is for protein supplements for livestock feeding, but other protein supplements are available for the same use. It is therefore necessary to take into account the total quantity of oilseed meals and animal protein supplements available.[1] The relation between the price of corn and the price of supplements also affects feeders' willingness to buy supplements. This price relationship is affected by the quantity of corn available as well as by the quantity of protein supplements available. So the size of the corn supply must be considered. Also, regardless of the size of consumers' incomes, the demand for protein supplements is affected by the number of grain-consuming livestock to be fed.

In the present analysis of the factors affecting soybean-meal prices, a reasonably high correlation between actual and estimated weighted composite prices of all protein supplements for the periods 1935-36 to 1941-42 and 1946-47 to 1948-49 was obtained by basing estimates on the influence of three factors: (1) disposable personal income[2]; (2) the production of protein supplements (in terms of meal equiva-

[1] These include soybean meal, cottonseed meal, linseed meal, copra meal, peanut meal, gluten feed and meal, tankage, meat scraps, and fish meal. Wheat-milling by-products were not used.

[2] Income for October to September was used in order to correspond with the crop year. Prior to 1939 calendar-year data were interpolated.



Composite prices of four edible fats and oils (soybean oil, cottonseed oil, lard, and butterfat) and prices of soybean oil; composite prices of protein supplements (meal-equivalent basis) and prices of soybean meal; disposable personal income, United States: 1929-30 to 1948-49. (Fig. 1)

lent) per grain-consuming animal unit (except horses and mules); and (3) the corn supply (production plus carryover) per grain-consuming animal unit (except horses and mules) (Figs. 1 to 4). Several other combinations of factors were tried and discarded.

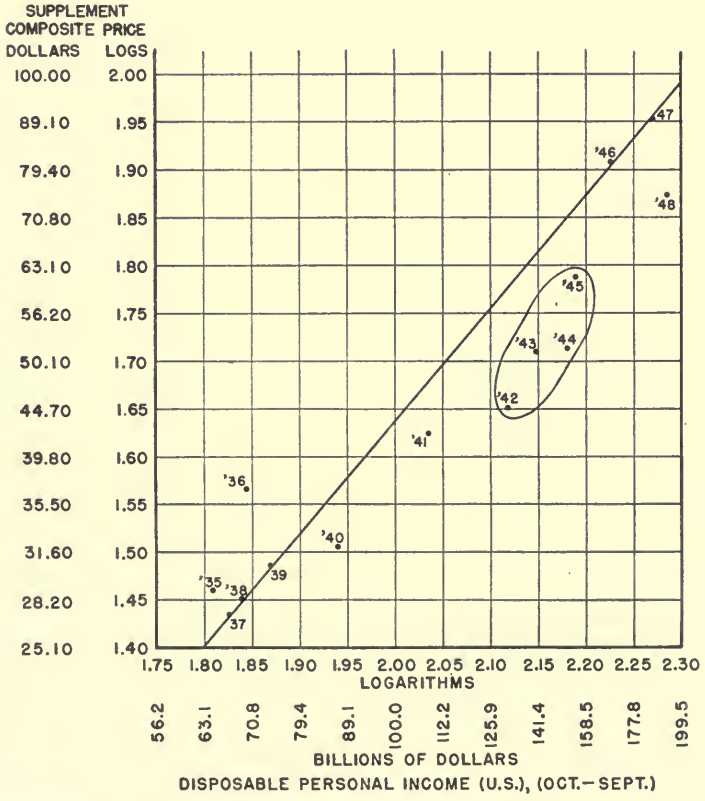
Logarithms of the data were used for the dependent variable, the weighted annual composite price per ton of protein supplements, and for the independent variables 1 and 2 described above. However, numbers of bushels were used instead of logarithms for the independent variable 3. The use of logarithms facilitates comparisons of proportional (percentage) changes between two variables rather than changes in absolute terms. Where there are such large differences in values over a period of years as occurred in this study, the relation between the percentage changes of two variables would seem to be more significant than just the relation between changes in actual values. Also a higher correlation was obtained by using logarithms (in some of the charts actual values are indicated on the scales to correspond with the logarithms used). The relation between supplement prices and corn supplies per animal unit did not appear to be proportional; hence the use of numbers of bushels instead of logarithms for that factor.

With this method a large fraction of the year-to-year variation in the weighted average composite price of protein supplements has been explained. It remains to explain the variations between changes in the price of soybean meal and the changes in the composite price of the protein supplements. Actually from 1939-40 to 1948-49 the price of 41-percent soybean meal at Chicago varied less than $2 a ton from the computed weighted composite price of all the protein supplements.

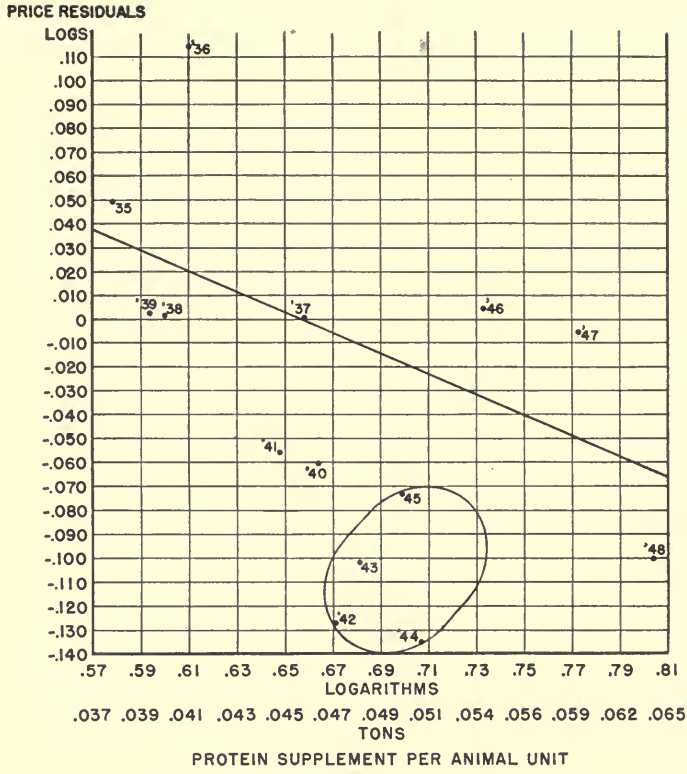
Interpretation of analysis. A price (in logarithms) that corresponds with the anticipated disposable personal income (also converted to logarithms) is read on the left-hand scale of Fig. 2. Let us say that disposable income is expected to be 199.5 billion dollars. The logarithm on the lower horizontal scale is 2.30. The logarithm of price that corresponds to that (intersection of diagonal and vertical lines) is 1.992 (or $98.18). If we assume that protein-supplement supplies are equal to 1948-49 supplies (0.0636 ton per grain-consuming animal unit), we deduct from our original logarithmic value of 1.992 the fraction 0.064, which is the vertical distance from the diagonal line to the zero line (at the logarithm of 0.0636 on the horizontal scale, or 0.80) in Fig. 3. This leaves 1.928 (or $84.72). If now we assume a bumper crop of corn amounting to 25 bushels per animal unit, we deduct 0.045, the vertical distance from the diagonal line to the zero

line in Fig. 4, from the 1.928, leaving a logarithmic value of 1.883 (or $76.38) as the estimated composite price of all the protein supplements when converted to a meal-equivalent basis.

The slope of the line in Fig. 2 indicates that a rise or fall of 0.100 in terms of logarithms of disposable personal income (in billions of dollars) was associated with a rise or fall in the same direction of about 0.119 in terms of logarithms of prices of all the protein supplements (in dollars per ton). That means that for every rise of 1 percent in disposable personal income, the composite price of the protein supplements (combined on a meal-equivalent basis and each weighted according to actual production) rose almost 1.2 percent. The declines were in the same proportion.



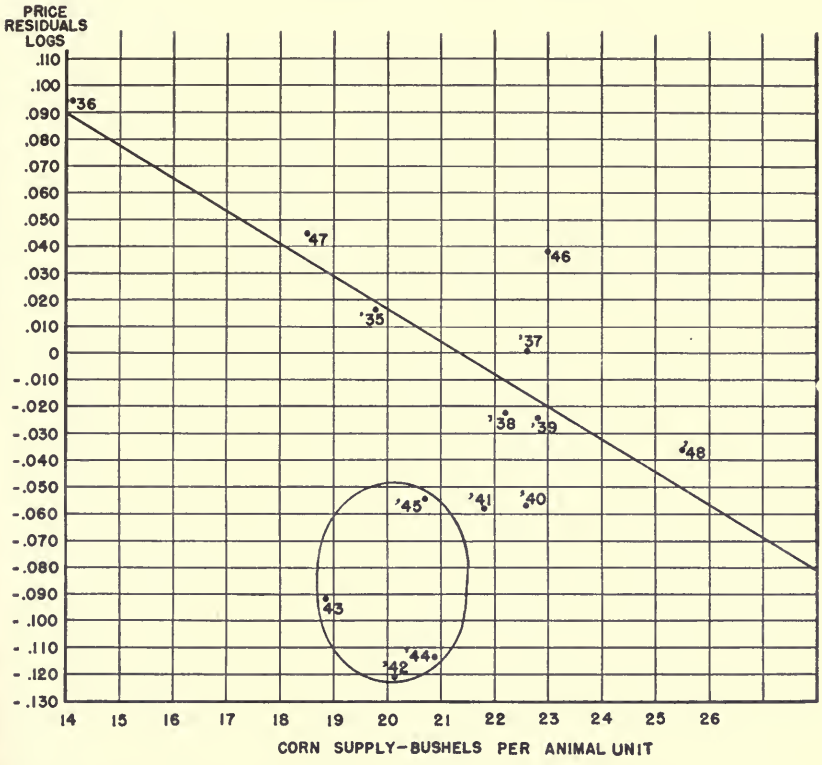
Relation between disposable personal income, United States, and composite price of protein supplements (meal-equivalent basis): 1935-36 to 1948-49. (Fig. 2)



Relation between composite prices of protein supplements and supplies of protein supplements (meal-equivalent basis) per grain-consuming animal unit except horses and mules: 1935-36 to 1948-49. (For convenience, the characteristic 8 minus 10 for the logarithms of the supplies has been omitted.) (Fig. 3)

In Fig. 3 the deviations of prices from those explained by the size of the disposable personal income (the vertical differences between the plotted values and the corresponding values on the diagonal line in Fig. 2) are related to the production of all the protein supplements. This chart indicates that as the quantity of protein supplements (meal-equivalent basis) increases 1 percent, the price of protein supplements declines approximately 0.43 percent. Thus the influence of a change of 1 percent in the production of protein supplements on changes in the price of the protein supplements was about one-third as large as the influence of a change of 1 percent in disposable personal income.

In Fig. 4 the unexplained portion of prices (measured as vertical distances between the actual points on Fig. 3 and corresponding values



Relation between composite prices of protein supplements and corn supply per grain-consuming animal unit except horses and mules: 1935-36 to 1948-49. (Fig. 4)

on the diagonal line) is correlated with corn supply per grain-consuming animal unit (except horses and mules). The price residuals are in logarithms but the corn supply is in bushels. In this case an increase in the corn supply of one bushel per animal unit was associated with a decline in the price of protein supplements of approximately 2.5 percent.

The three factors used (disposable personal income, quantity of protein supplies produced per animal unit, and corn supply per animal unit) accounted for more than 97 percent of the year-to-year variations in the logarithms of the composite price of protein supplements during the nonwar years covered in the study. Since data for only nine years were used, the results are not as reliable as they appear, but they are the best that can be obtained until more data are at hand. Protein

prices were higher the first year after price ceilings were removed, 1946-47, than would have been expected on the basis of these relationships. They were low in 1940-41 and 1941-42.

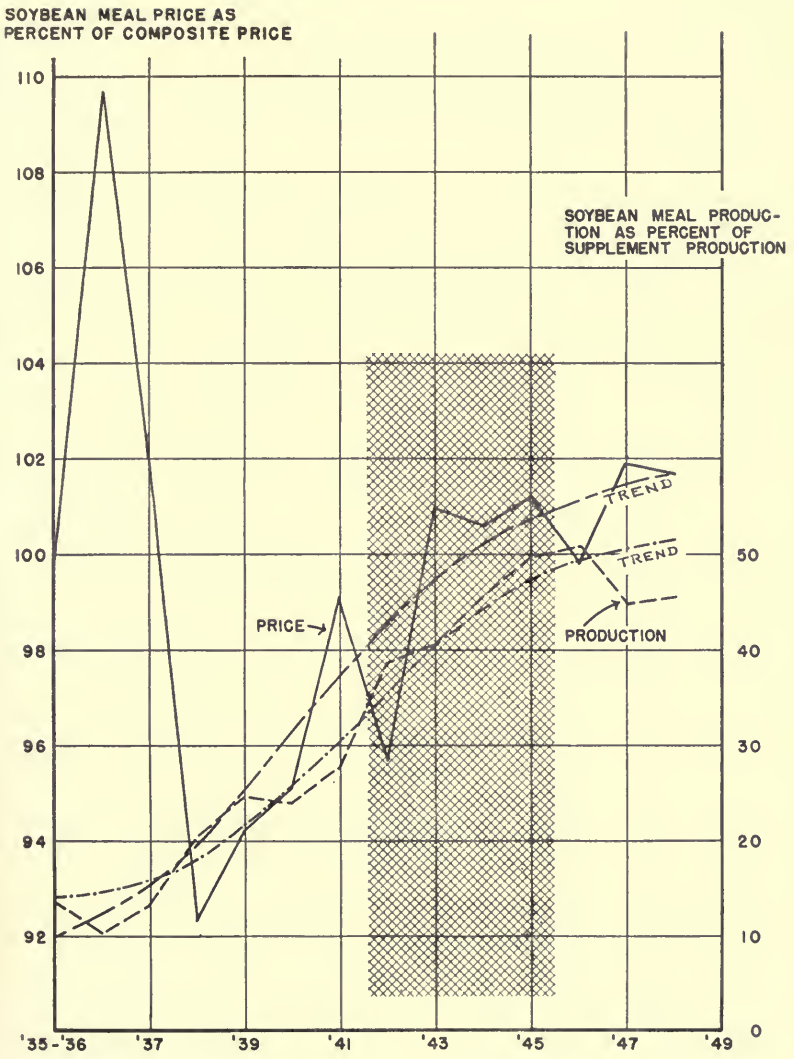
We have now devised a way to estimate the composite price of protein supplements. This is a weighted price and the weights used are the production of each protein supplement converted to a meal-equivalent basis. The adjustments to "meal equivalent" is made by multiplying by a factor which will adjust for the protein content. The multipliers used were as follows: gluten feed and meal, 0.70; copra cake and meal, 0.50; tankage, meat scraps and fish meal, 1.4. The actual production figures were multiplied by the actual prices of each commodity and the total value was divided by the adjusted total production, that is, total production on a meal-equivalent basis. That gave a weighted value per ton of supplement on a meal-equivalent basis.

In estimating the probable price of soybean meal[1] we would use the estimated price of protein supplement from the charts. Because of the dominant position now occupied by soybean meal so far as supplies of supplements are concerned, the composite price and the soybean-meal price will agree rather closely.

Sometimes the price of soybean meal might be relatively high because of low supplies of all meals compared with the supplies of animal protein supplements, or the opposite situation might prevail when meal supplies are high relative to supplies of animal protein. An example of the first situation occurred in 1936-37, a year of severe drouth, when the price of soybean meal rose to 9 percent above the composite price of all protein supplements (converted to meal equivalent). This price behavior was probably related mainly to the livestock liquidation (and relatively high production of animal proteins) that occurs during drouths; but it was also related to the fact that oilseed production was reduced by the drouth.

As indicated by Fig. 5 and Table 8, soybean-meal production has become an increasingly larger fraction of the total production of supplements included in this analysis. As this occurred, the price of soybean meal was bound to exert increasing influence on the composite price, causing the two to come closer together. Note that in 1947-48 and 1948-49, when soybean-meal production had become such a large part of the total meal production, soybean-meal prices were very close to the composite price, being 101.9 and 101.7 percent of it.

[1] Prices refer to soybean meal, bagged, in wholesale lots at Chicago.



Soybean-meal prices as percentage of composite price of protein supplements, and production of soybean meal as percentage of production of all protein supplements: 1935-36 to 1948-49. (Fig. 5)

Since soybean-meal production appears to have about reached its maximum peacetime percentage of total supplement production, the present (1949-50) relation between prices of soybean meal and the composite price of all protein supplements should continue. Fig. 5

shows graphically this leveling off of both the production trend and the price trend.

Of course drouths, or peaks or troughs in the livestock cycles (hence in tankage and meat-scrap production), could cause some slight variations in the above production and price relationships. But if we are right in assuming that these relationships are fairly well stabilized, we can then assume that soybean-meal prices will agree fairly well with the estimated composite price of the supplements used in this analysis.

Soybean Oil Prices

The price of soybean oil is closely related to the prices of competing edible fats and oils. The composite prices of all edible fats and oils, in combination, are determined largely by the amount of disposable personal income of people in the United States and by the supply of edible fats and oils in the United States. (Supplies available for use in any one year include those produced in that year, the carryover from the previous year, and imports.)

In this analysis the war years during which prices were controlled are omitted. For the periods before and after these years, 1929-30 to 1941-42 and 1946-47 to 1948-49, the composite price[1] of soybean oil, cottonseed oil, lard, and butterfat, all weighted by their supplies, rose 1.01 percent with every rise of 1 percent in disposable personal income[2]—for all practical purposes a one-to-one relationship (Fig. 6).

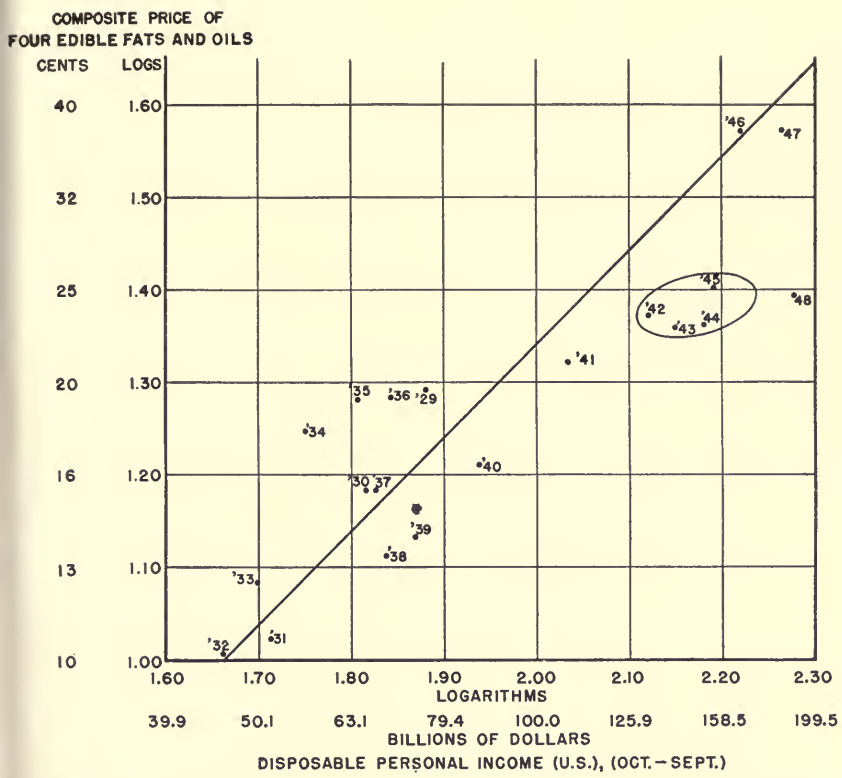
After correcting for changes in consumers' ability to buy—that is, for changes in their disposable personal income—it was found that the composite price for these four fats and oils declined 1.44 percent with every 1-percent increase in their supplies (Fig. 7).

Prices of edible fats and oils are sensitive to changes in both demand and supply. These two factors appear to account for about 95 percent of the year-to-year fluctuations in the logarithms of the composite price.

Using Figs. 6 and 7 for estimating prices of fats and oils in the same way that Figs. 2, 3, and 4 were used to estimate the prices of

[1] The composite price was obtained by using crop-year prices multiplied by crop-year production plus carryover at the end of the crop year or on January 1 and imports for the ensuing calendar year for each item, summed, and divided by total supplies of all four items.

[2] Data on disposable personal income are for October to September, thus corresponding with the crop year. Prior to 1939 calendar-year data were interpolated.



Relation between composite prices of four edible fats and oils and disposable personal income, United States: 1929-30 to 1948-49. (Fig. 6)

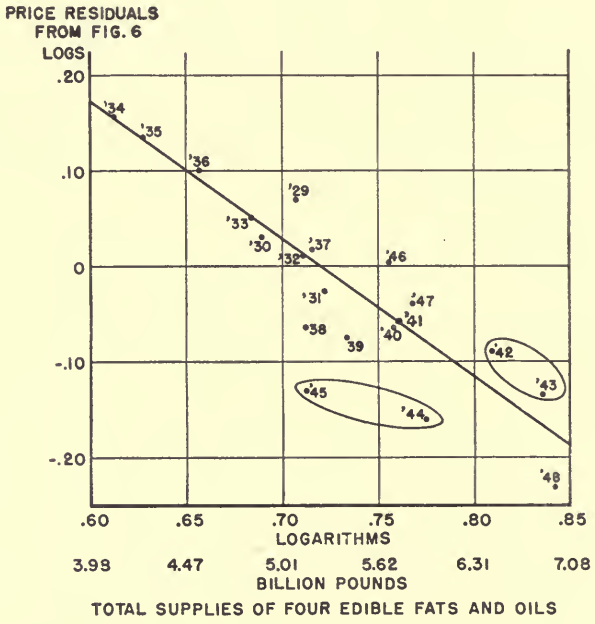
protein supplements, we obtain the estimated composite prices for these fats and oils. It is then necessary to estimate the price of soybean oil.[1]

In recent years soybean oil has made up an increasing share of the total supplies of the four edible fats and oils: soybean oil, cottonseed oil, lard, and butterfat (Fig. 8)—until the composite price has become rather heavily weighted by soybean-oil prices, and the actual soybean-oil prices have come closer and closer to the composite price.

In recent years soybean-oil prices have averaged approximately 55 percent as high as the composite price of the four edible fats and oils. The composite price has been higher because it has included prices of butterfat. If, compared with the most recent five-year aver-

[1] Prices used in this study refer to crude soybean oil in tank-car lots at midwestern mills, weighted by volume of sales.

age, the supplies of soybean oil plus cottonseed oil increase much more or decrease much less than the supplies of lard plus butterfat, soybean-oil prices will drop until they are around 50 percent as high as the composite price. With opposite supply relationships, soybean-oil prices may go as high as 60 percent of the composite price. In 1948-49 soybean-oil supplies plus cottonseed-oil supplies made up 50.6 percent

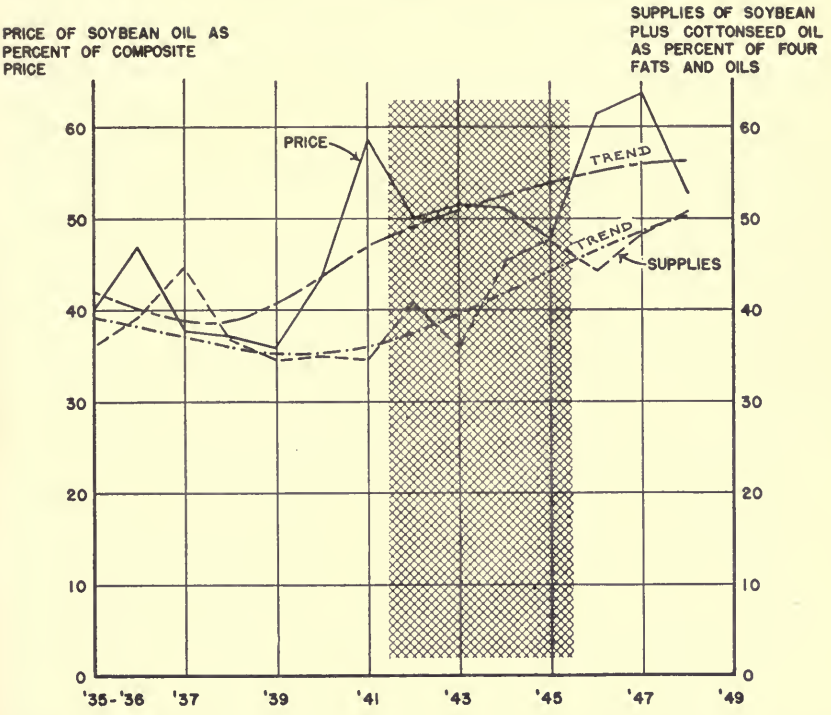


Relation between the composite price of four edible fats and oils (soybean oil, cottonseed oil, lard, and butterfat) and total supplies: 1929-30 to 1948-49. (Fig. 7)

of the supplies of the four edible fats and oils and soybean-oil prices were 52.8 percent of the composite price. In 1947-48 figures were 48.0 for supplies and 63.4 for prices. In 1946-47 the comparable figures were 44.0 and 61.3.

For forecasting purposes it would be necessary to estimate carry-overs and production of all four edible fats and oils. Some knowledge of probable imports would help, but for these fats and oils imports are not large enough to exert much influence on soybean prices under present-day (1951) conditions. Their influence has therefore been ignored in this study.

It would also be necessary, for forecasting purposes, to have an



Supplies of soybean oil plus cottonseed oil as percentage of supplies of four edible fats and oils; and price of soybean oil as percentage of composite price of four edible fats and oils (soybean oil, cottonseed oil, lard, and butterfat): 1935-36 to 1948-49. (Fig. 8)

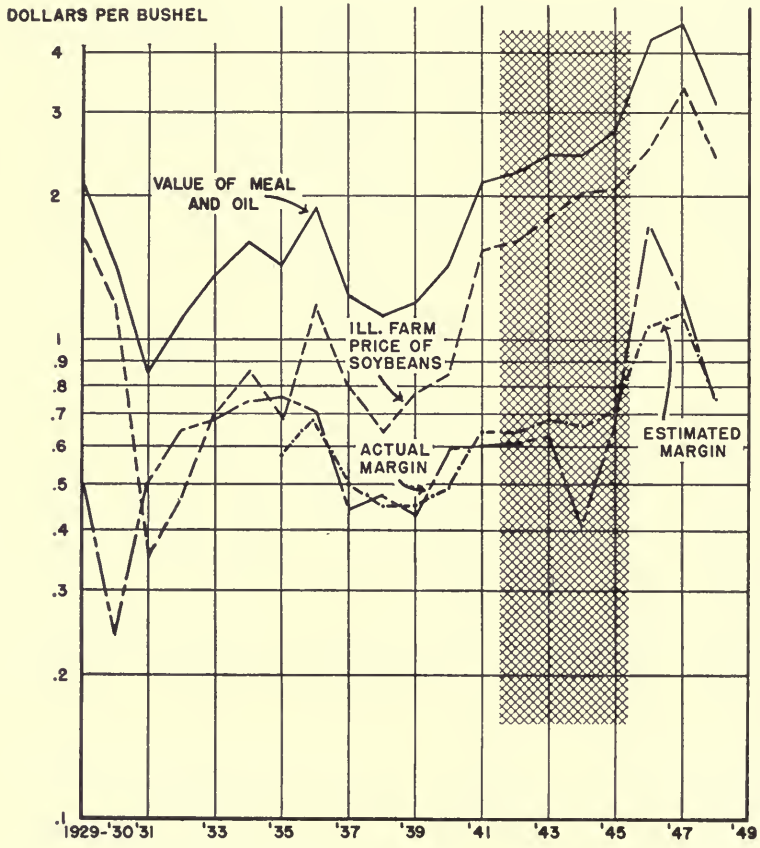
estimate of the level of disposable personal income. Such estimates are made from time to time by agencies of the government and can be obtained from that source.

Soybean Prices as Related to Value of Meal and Oil

As processing techniques have improved, the number of pounds of oil obtained from a bushel of soybeans has increased and the number of pounds of meal has decreased. A reasonable figure to use at present is 10 pounds of oil and 48½ pounds of meal. Some processors get more oil, hence correspondingly less meal, by using new equipment and the latest methods of extraction.

Soybeans are worth the value of the oil and meal less all transportation, handling, and processing costs from the local bean market until the oil and meal are processed and sold by the processor.

The weighted crop-year Illinois farm prices of soybeans and the differences between the value of the products—meal and oil—and the price of soybeans are shown in Fig. 9.[1] A logarithmic, or ratio,



Relation between the value of soybean meal and soybean oil and the Illinois farm price of soybeans: 1929-30 to 1948-49. (Fig. 9)

[1] The margins shown here are a little larger than actual margins because soybean and oil prices are weighted (seasonally) by sales, but the annual price of meal is a simple average of monthly prices. Processors have sold large quantities of oil and meal directly to users in early winter to be delivered late in the year. The annual price should therefore give more weight to October, November, and December prices. Because spot sales of oil instead of forward sales were sometimes used as weights, and because meal prices were not weighted by sales of any kind, the margin is too large. This does not, however, affect the usefulness of the data used for the purpose of forecasting the prices of the soybean meal, oil, or beans. The bias tends to be uniform throughout.

scale is used. If the margin had increased in proportion to the price of beans, the two lines would have had the same slope; they would have remained equidistant regardless of whether prices were rising or falling. Except for 1946-47, the first year after the removal of price ceilings, the margin has been rather stable in dollars but has declined as a percentage of the price of soybeans. Doubtless "sticky" freight rates, improved methods of processing, and competition have tended to hold down the margin in this period of rising prices.

For the period studied, excluding the war years, the marketing and processing margin has tended to fluctuate around a figure equal to 25 cents plus 25 percent of the value of meal and oil combined, as used in this analysis, less 2 cents a year beginning with 1935-36 as year 1 and counting the war years. The agreement between actual margins and margins estimated by this formula is fairly close. There appears to be a gradual decline in margins compared with actual values of the products. This decline is represented by subtracting a value that increases 2 cents a year beginning with 1935-36 as year one. There also seems to be a base below which margins do not fall. The base used here is 25 cents. There also appears to be some adjustment necessary for changes in costs of handling and processing caused by inflation or deflation, which is accounted for by using 25 percent of the combined value of the products.

The above formula cannot, however, be used over a long period of time because it includes a constant decline, which would eventually mean no margin. The soybean processing industry is in a dynamic stage of development, so the factors affecting margins should be reviewed frequently.

The windfall profits or losses resulting from rapid changes in prices of the products after harvest are received by the owners of the product. If the farmers sell their beans at harvest time and the processors sell the meal and oil for future delivery to actual users, then the product users make the gains or incur the losses.

Seasonal Pattern of Soybean Prices

For the period 1930-31 to 1940-41 the lowest prices received by Illinois and United States farmers for soybeans tended to be in October. The highest prices were in May and June. The monthly figures, calculated as percentages of the average yearly price after making adjustments for changes in demand and year-to-year changes in supplies, were as follows: October, 82; November, 89; December, 96; January,

102; February, 103; March, 107; April, 110; May, 115; June, 114; July, 105; August, 90; and September, 88.

This pattern has changed as production has increased and marketing procedures have changed. From 1931-32 to 1935-36 the October low was about 78, from which there was a steep rise to about 122 in June. July was only a little lower than June. After July there was a very rapid decline. From 1936-37 to 1940-41 the seasonal fluctuations were somewhat less pronounced, and the peak was reached earlier in the season. The October price was about 85 percent of the crop-year average, and the peak was reached in May at approximately 114 percent of the yearly average. No consideration is given to the war years because the OPA did not permit the usual forces to operate then and little seasonal variation occurred. Since abandonment of price ceilings, the price movements have been erratic, but the amount of seasonal spread has been about the same on a percentage basis as in the period from 1936-37 to 1940-41. The timing of the peak in prices appears to have advanced a little to April or May, and a larger fraction of the rise has occurred by January than was true before the war.

The postwar seasonal price pattern would be approximately as follows: October, 85; November, 100; December, 100; January, 105; February, 100; March, 110; April, 114; May, 105; June, 105; July, 102; August, 92; September, 82. The heavy penalty on October sellers has persisted into the postwar period. Since there may be some tendency to return to prewar seasonal patterns, the figures for the two periods are averaged here:

October.....84	January.....103	April.....112	July.....103
November.....94	February.....102	May.....110	August.....91
December.....98	March.....108	June.....109	September.....85

The reasons for this very large seasonal price spread have been explained.[1] The spread is believed to be related to and largely caused by the heavy marketings by farmers at harvest time, combined with the inability of processors to hedge their purchases to advantage in the "futures" markets. Processors have been obliged to carry the price risk, which they are not prepared to do, or to sell oil and meal to actual users for later delivery. These users have demanded and obtained substantial price concessions for carrying the risk. The seasonal movements of soybean-meal and soybean-oil prices have been small compared with the seasonal movements of prices for the beans.

[1] Hieronymus, T. A., and Jordan, G. L., Farm Storage of Soybeans Carries Small Price Risk. *Illinois Farm Economics,* University of Illinois, October, 1949. Reprinted in *The Soybean Digest,* January, 1950.

The farmer is in a better position than the processor to carry this seasonal price risk and should store more beans on the farm rather than sell such a large fraction at harvest time. Unless interfered with because of war influences, increased participation in the soybean "futures" markets, particularly by speculators who are willing to buy when processors wish to sell, and vice versa, will, it would seem, facilitate hedging by processors and thereby reduce the seasonal price spread. More farm storage would have the same effect. But for the next few years the forces which have caused this wide seasonal spread will continue to operate in the absence of government price controls such as price ceilings or price supports above the freely competitive market price.

It should be emphasized that the seasonal price movements referred to here are movements after the influence of changes in demand have been eliminated. A rise in demand for meal or oil would cause prices to rise more than seasonally or fall less than seasonally, and a decline in demand would have the opposite effect. Likewise, a very large crop of soybeans could seriously depress prices at harvest because of lack of storage space. The seasonal rise would tend to be larger than normal.

Summary

Prices received by farmers for soybeans depend on the prices that consumers will pay for meat and other animal products, margarine, and vegetable shortenings; on the size of the livestock population; the supplies of protein supplements, corn, and edible fats and oils; and the costs and profits of handlers, transportation agencies, and processors. The dominant causes of year-to-year variations in soybean prices are changes in the ability of the United States consumer to buy these related products and in the quantities of protein supplements and edible fats and oils available.

In the absence of price ceilings or effective price supports, prices of soybean meal can be expected to change during the next few years about 1.2 times as much (in percentage) as disposable personal income, and in the same direction. Meal prices can be expected to move in the opposite direction to changes in supplies of the supplements used in this analysis (converted to a meal-equivalent basis) and about 0.40 to 0.45 as much (in percentage). An increase of one bushel per animal unit in the corn supply would tend to drive down the price of meal about 2.5 percent. During the next few years the actual price of soybean meal will probably be about the same as the

weighted composite price of all the supplements used in this analysis when converted to a meal-equivalent basis.

Soybean-oil prices, in the absence of price controls or effective price supports, will change in the same direction and to about the same extent (percentage) as disposable personal income changes. They will also tend to change about 1.4 to 1.5 percent in the opposite direction with every 1 percent change in supplies of the four edible fats and oils — soybean oil, cottonseed oil, lard, and butterfat. The actual price of soybean oil will be approximately 55 percent as high as the weighted composite price of the four edible fats and oils.

From the combined value of the oil and meal must be deducted the marketing and processing costs. These costs fluctuate rather widely. They have become somewhat stabilized, however, since 1934-35 around a figure equal to 25 cents a bushel plus 25 percent of the value of the meal and oil minus 2 cents for every year since 1934-35 (cumulative).

Up to World War II, as soybean production expanded rapidly and the market became a little better organized, the seasonal spread in soybean prices from the October low to early summer high declined somewhat. Since World War II the October price has continued to be very low compared with the yearly average price (after corrections are made for changes in demand and production); but the peak has come sooner—in April or May—and much of the rise has occurred by January. More farm storage until January or May will probably pay growers for several years unless we get into a period of price controls. In case price controls are applied, some consideration will have to be given to the matter of orderly marketing, either by allowing seasonal variations in prices or by paying farmers or others a fee for storing.

TABLES

Table 1. — Illinois Farm Prices of Soybeans, and Amount of Disposable Personal Income in the United States, 1929-30 to 1948-49

Year	Illinois farm price of soybeans[a]	Disposable personal income[b]	Year	Illinois farm price of soybeans[a]	Disposable personal income[b]
	per bu.	*billions*		*per bu.*	*billions*
1929	$1.61	$75.9	1939	$ .77	$ 74.0
1930	1.18	65.7	1940	.85	86.9
1931	.35	51.6	1941	1.54	108.8
1932	.47	45.8	1942	1.60	131.9
1933	.71	50.0	1943	1.80	141.3
1934	.86	56.4	1944	2.04	151.8
1935	.68	64.1	1945	2.08	154.8
1936	1.18	69.8	1946	2.52	166.2
1937	.80	66.9	1947	3.39	184.1
1938	.64	69.0	1948	2.40	189.4

[a] From *Illinois Agricultural Statistics*, No. 445 (p. 130), Illinois Cooperative Crop Reporting Service. Crop years 1929-1944 begin in September; 1945-1948 begin in October; all are weighted averages.

[b] From U. S. Department of Commerce, Bureau of Foreign and Domestic Commerce, *Survey of Current Business* (National Income Number), July, 1950 (pp. 30-31). Crop year is computed by interpolation, except for 1939-1948.

Table 2. — Average Price per Ton of Protein Supplements, Bagged, in Wholesale Lots at Leading Markets, 1935-36 to 1948-49[a]

Year beginning Oct. 1	Soybean meal, 41 percent, Chicago	Linseed[b] meal, Minneapolis	Cottonseed meal, 41 percent, Memphis	Peanut meal, 45 percent, f.o.b. southeastern milling points	Gluten feed, 23 percent, Chicago	Copra meal,[b] Los Angeles	Tankage digester, 60 percent, Chicago	Meat scraps, Chicago	Fish meal, 67 percent, San Francisco
1935	$28.66	$31.04	$24.33	$24.17	$23.52	$24.95	$48.15	.....	$36.21
1936	40.61	40.80	32.88	35.69	31.57	34.81	55.69	.....	44.73
1937	27.71	39.71	22.01	24.98	22.58	28.73	46.01	.....	42.48
1938	25.98	36.90	22.50	22.06	18.78	24.74	52.57	.....	42.57
1939	28.90	29.89	27.99	29.36	22.22	22.95	49.66	.....	51.20
1940	30.49	29.65	28.50	25.56	23.17	29.32	53.14	.....	61.46
1941	41.87	37.56	36.33	40.57	28.69	47.33	74.15	.....	74.61
1942	42.80	44.79	40.10	40.57	32.39	52.30	74.55	.....	79.50
1943	51.91	45.50	48.50	53.00	40.94	50.98	74.55	.....	79.50
1944	52.00	45.50	48.54	53.00	41.27	49.92	74.55	$72.90	79.50
1945	62.39	55.57	60.08	61.32	48.85	53.58	82.75	81.77	83.46
1946	81.10	81.54	75.83	74.01	58.28	70.85	110.63	101.80	159.52
1947	91.61	81.27	83.20	83.19	74.47	85.33	119.39	110.82	163.19
1948	76.39	67.24	63.12	65.48	53.78	67.34	120.65	116.54	193.45

[a] Figures are from U. S. Bureau of Agricultural Economics, *Feed Statistics*, 1946 Annual (p. 60), and 1949 Annual (pp. 71-76). The percentages refer to protein content.

[b] Variable protein content.

Table 3. — Production of Protein Supplements in the United States, 1935-36 to 1948-49

(In thousands of tons)[a]

Year beginning Oct. 1	Soybean cake and meal	Linseed cake and meal	Cottonseed cake and meal	Peanut cake and meal	Gluten feed and meal	Copra cake and meal	Tankage	Meat scraps	Tankage[b] and meat scraps	Fish meal
1935	613.1	456.9	1 791.2	45.9	588.0	78.4	.....	.....	642.0	200.0
1936	495.8	586.1	2 145.7	57.0	510.5	63.6	.....	.....	634.0	206.4
1937	724.1	412.0	2 759.1	48.2	545.2	77.7	.....	.....	608.0	175.5
1938	1 064.4	481.4	1 969.9	65.0	566.9	74.8	.....	.....	667.0	194.8
1939	1 348.8	538.9	1 775.0	30.3	614.4	90.3	.....	.....	728.0	190.7
1940	1 543.4	744.7	1 988.3	133.5	758.6	90.8	.....	.....	802.0	226.9
1941	1 844.9	902.2	1 791.7	57.3	964.6	48.1	.....	.....	835.0	184.2
1942	3 200.3	797.6	2 014.9	103.0	927.3	33.7	.....	.....	877.0	194.9
1943	3 446.0	997.0	1 749.0	108.7	842.1	32.9	.....	.....	975.0	190.3
1944	3 698.5	449.4	1 916.3	92.2	863.9	42.3	193.2	540.3	733.5	204.8
1945	3 837.3	562.4	1 409.8	80.1	801.7	67.6	154.8	538.1	692.9	187.9
1946	4 086.4	374.1	1 428.3	113.0	1 040.1	194.2	161.4	528.9	690.3	183.3
1947	3 832.8	625.0	2 015.6	107.3	799.1	169.9	178.2	571.8	750.0	188.5
1948[c]	4 328.2	686.8	2 416.3	93.7	848.3	118.0	184.0	591.4	775.4	173.9

[a] Figures are from U. S. Bureau of Agricultural Economics, *Feed Statistics*, 1949 Annual (pp. 59, 60, 66).

[b] Tankage and meat scraps for 1935-1943 are estimated amounts used for feed (*Feed Statistics*, 1949 Annual, p. 59). Figures for 1944-1948 are reported production, estimated to be 95 percent or more of the total United States production.

[c] Preliminary for all except tankage and meat scraps (U. S. Bureau of Agricultural Economics).

Table 4. — Value of Protein Supplements, and Composite Price per Ton in Terms of Meal Equivalent, 1935-36 to 1948-49

Year beginning Oct. 1	Value of various supplements as derived from price × production (to be multiplied by 1,000)											Composite price per ton of supplement in terms of meal equivalent[a]
	Soybean cake and meal	Linseed cake and meal	Cotton-seed cake and meal	Peanut cake and meal	Gluten feed and meal	Copra cake and meal	Tankage	Meat scraps	Tankage and meat scraps	Fish meal	Sum	
1935	$ 17 571	$14 182	$43 580	$1 109	$13 830	$1 956	.....	.....	$30 912	$ 7 242	$130 383	$28.74
1936	20 134	23 913	70 551	2 034	16 116	2 214	.....	.....	35 307	9 232	179 502	37.01
1937	20 065	16 361	60 728	1 204	12 311	2 232	.....	.....	27 974	7 455	148 329	27.16
1938	27 653	17 764	44 323	1 434	10 646	1 851	.....	.....	35 064	8 293	147 027	28.16
1939	38 980	16 108	49 682	890	13 652	2 072	.....	.....	36 152	9 764	167 301	30.67
1940	47 058	22 080	56 667	3 412	17 577	2 662	.....	.....	42 618	13 945	206 020	32.06
1941	77 246	33 887	65 092	2 325	27 674	2 277	.....	.....	61 915	13 743	284 159	42.27
1942	136 973	35 724	80 797	4 179	30 035	1 763	.....	.....	65 380	15 495	370 346	44.71
1943	178 882	45 363	84 826	5 761	34 476	1 677	.....	.....	72 686	15 129	438 801	51.39
1944	192 322	20 448	93 017	4 887	35 653	2 112	$14 403	$39 388	.....	16 282	418 511	51.69
1945	239 409	31 253	84 701	4 912	39 163	3 622	12 810	44 000	.....	15 682	475 552	61.62
1946	331 407	30 504	108 308	8 363	60 617	13 759	17 856	53 842	.....	29 240	653 896	81.23
1947	351 123	50 794	167 698	8 926	59 509	14 498	21 275	63 367	.....	30 761	767 951	89.93
1948	330 631	46 180	152 517	6 135	45 622	7 946	22 200	68 922	.....	33 641	713 794	75.08

[a] Composite price is derived by dividing total value of all nine supplements by total tons of meal of equivalent protein content. The multipliers used in order to convert all supplements to a common protein basis were: gluten feed and meal, 0.70; copra cake and meal, 0.50; tankage, meat scraps and fish meal, 1.4; soybean, linseed, cottonseed, and peanut cake and meal, 1.00 (*The Feed Situation*, Oct., 1949, p. 15).

Table 5. — Prices of Four Edible Fats and Oils: Crude Soybean Oil, Cottonseed Oil, Lard, and Butterfat, 1929-30 to 1948-49

Year beginning Oct. 1	Crude soybean oil per pound[a]	Crude cottonseed oil per pound[b]	Refined lard per hundred pounds[c]	Butterfat, price per pound received by farmers[d]	Composite price per pound for all four fats[e] and oils
	cents	*cents*		*cents*	*cents*
1929	9.09	7.29	$12.05	37.32	19.55
1930	6.33	6.41	10.04	26.78	15.25
1931	3.44	3.19	6.83	20.51	10.56
1932	4.60	3.51	6.23	18.71	10.15
1933	5.86	4.07	7.62	21.23	12.14
1934	7.76	8.48	14.29	27.70	18.54
1935	7.42	8.63	12.65	31.56	19.11
1936	9.06	9.15	12.57	32.90	19.25
1937	5.72	6.60	9.90	29.31	15.28
1938	4.83	5.96	7.67	23.62	13.02
1939	4.95	5.64	6.67	27.60	13.55
1940	7.04	6.54	8.62	33.21	16.24
1941	11.22	12.27	13.62	37.64	20.86
1942	11.75	12.75	15.53	49.50	23.51
1943	11.75	12.75	15.55	50.68	22.88
1944	11.75	12.75	15.55	50.54	23.00
1945	11.91	12.75	18.75	56.52	25.22
1946	22.86	24.78	27.10	74.47	37.30
1947	23.76	26.25	26.04	82.12	37.45
1948	13.10	15.42	17.08	62.77	24.84

[a] Average price per pound in tank cars, midwestern mills. Prices are weighted by carlot sales. From *Agricultural Statistics*, 1949 (p. 152), 1942 (p. 201). USDA Tech. Bul. 619, June, 1938.

[b] Average price per pound in tanks f.o.b. southeastern mills. From *Agricultural Statistics*, 1940 (p. 136), 1942 (p. 170), 1949 (p. 134).

[c] Average wholesale price per hundred pounds for crop year, Chicago. From *Livestock Market News Statistics*, 1948 (p. 64), and *Agricultural Statistics*, 1942 (p. 410). *Fats and Oils Situation*, 1949, January through September (p. 2). *Livestock, Meat, and Wool Market Statistics*, 1943 (p. 74).

[d] Crop year computed by averaging monthly prices. From *Dairy Situation*, May, 1950 (p. 39).

[e] Composite price calculated as follows: supplies multiplied by price for each product; results totaled for each year and divided by total supplies.

Table 6. — Supplies of Four Edible Fats and Oils, United States, 1929-30 to 1948-49

(In millions of pounds)

Year	SOYBEAN OIL[a]			COTTONSEED OIL[b]			BUTTERFAT[c]			LARD[d]			All four fats and oils, sum of supplies
	Production crude basis	Imports	Total supply	Production crude oil	Imports	Total supply	Production	Cold-storage stocks	Total Supply	Production, crop year	Stocks December 31	Total supply	
1929	13.4	13.3	26.8	1 572	(•)	1 572.0	1 683.0	126.8	1 809.8	1 600.1	82.1	1 682.2	5 090.8
1930	34.7	5.9	40.6	1 442	(•)	1 442.0	1 735.3	105.2	1 840.5	1 509.5	51.4	1 560.9	4 884.0
1931	39.9	3.1	43.0	1 694	0	1 694.0	1 835.8	64.1	1 899.9	1 585.2	51.2	1 636.4	5 273.3
1932	29.1	(•)	29.1	1 446	0	1 446.0	1 863.7	71.6	1 935.3	1 691.7	41.1	1 732.8	5 143.2
1933	26.2	2.5	28.7	1 303	0	1 303.0	1 813.0	139.8	1 952.7	1 425.4	132.5	1 557.9	4 842.3
1934	78.1	11.3	89.5	1 109	113.4	1 222.4	1 770.2	100.0	1 870.3	789.6	118.1	907.7	4 089.8
1935	209.0	11.3	220.2	1 164	145.9	1 309.9	1 669.3	119.1	1 788.4	870.0	52.7	922.7	4 241.2
1936	183.7	22.2	205.9	1 364	201.3	1 565.3	1 699.6	87.1	1 786.7	821.7	145.8	967.5	4 525.4
1937	279.3	12.1	291.4	1 961	70.7	2 031.7	1 749.0	95.0	1 844.0	958.3	53.7	1 012.0	5 179.1
1938	416.1	2.5	418.6	1 409	68.6	1 477.6	1 791.0	168.6	1 959.6	1 186.7	107.4	1 294.1	5 149.9
1939	533.4	5.2	538.6	1 325	10.8	1 335.8	1 764.8	123.7	1 888.4	1 485.1	162.1	1 647.2	5 410.1
1940	564.4	2.8	567.3	1 425	6.2	1 431.2	1 831.9	102.5	1 934.4	1 508.6	294.1	1 802.6	5 735.4
1941	706.7	(•)	706.7	1 250	31.0	1 281.0	1 718.7	162.4	1 881.1	1 700.2	198.5	1 898.7	5 767.5
1942	1 206.2	0	1 206.2	1 401	13.0	1 414.0	1 661.0	98.9	1 759.8	1 944.0	100.9	2 044.9	6 425.0
1943	1 219.5	(•)	1 219.5	1 236	4.3	1 240.3	1 476.2	186.0	1 662.2	2 541.2	200.2	2 741.4	6 863.3
1944	1 346.7	0	1 346.7	1 324	20.1	1 344.1	1 412.4	112.2	1 524.6	1 374.9	377.9	1 752.8	5 968.2
1945	1 414.7	(•)	1 414.7	1 018	18.9	1 036.9	1 152.3	151.9	1 304.2	1 310.9	91.6	1 402.5	5 158.4
1946	1 531.1	(•)	1 531.1	973	(•)	973.0	1 350.4	59.1	1 409.6	1 665.7	109.9	1 775.6	5 689.3
1947	1 532.7	.2	1 532.9	1 275	3.5	1 278.5	1 187.8	61.5	1 249.3	1 627.8	166.6	1 794.4	5 855.1
1948	1 805.9	.4	1 806.4	1 704	.9	1 704.9	1 322.4	75.1	1 397.5	1 855.5	173.3	2 028.7	6 937.4

[a] Data for soybean oil are from *Agricultural Statistics*, 1940 (p. 309), 1942 (pp. 201, 549), and 1949 (pp. 152, 497). Production is for year beginning in October. Imports are for year beginning in July and are from *Foreign Agricultural Trade*, Oct., 1950 (p. 37).

[b] Data for cottonseed oil are from *Agricultural Statistics*, 1940 (p. 136), 1942 (pp. 170, 549), and 1949 (pp. 134, 497). Production is for year beginning in August. Imports are for year beginning in July and are from *Foreign Agricultural Trade*, Oct., 1950 (p. 37).

[c] Data for butterfat are for year beginning in October and are from *Dairy Situation*, May, 1950 (pp. 27, 35); *Agricultural Statistics*, 1949 (p. 416); *Fats and Oils Situation*, Feb., Mar., Apr., 1950 (p. 23). Production of butterfat is the sum of creamery butter and farm butter multiplied by 0.80. Cold-storage stocks are stocks of butter multiplied by 0.80.

[d] Data for lard production are from *Livestock Market News Statistics*, 1943 (p. 90), 1946 (p. 78), 1949 (p. 70). Data for lard stocks are from *Agricultural Statistics*, 1942 (p. 409), and 1949 (p. 374).

• Less than 50,000.

Table 7. — Supplies of Protein Supplements and Corn, Total and per Grain-Consuming Animal Unit, United States, 1935-36 to 1948-49

Year beginning Oct. 1	Total production of protein supplement in meal equivalent[a]	Grain consuming animal units except horses and mules[b]	Quantity of protein (meal equivalent) per animal unit except horses and mules[c]	Corn[d]			Corn supply per grain-consuming animal unit except horses and mules
				Carryover October 1	Production	Total supply	
	1,000 tons	*millions*	*tons*	*1,000 bu.*	*1,000 bu.*	*1,000 bu.*	*bu.*
1935	4 536.7	199.5	.03796	64 788	2 299 363	2 364 151	19.784
1936	4 850.4	119.1	.04073	175 886	1 505 689	1 681 575	14.119
1937	5 460.7	119.9	.04554	65 655	2 642 978	2 708 633	22.591
1938	5 221.4	131.1	.03983	361 438	2 548 753	2 910 191	22.198
1939	5 454.5	139.0	.03924	583 740	2 580 985	3 164 725	22.768
1940	6 426.8	139.4	.04610	687 623	2 457 146	3 144 769	22.559
1941	6 722.2	151.2	.04446	644 677	2 651 889	3 296 566	21.803
1942	8 282.4	176.6	.04690	490 688	3 068 562	3 559 250	20.154
1943	8 538.0	177.9	.04799	384 101	2 965 980	3 350 081	18.831
1944	8 095.9	159.1	.05089	230 995	3 088 110	3 319 105	20.862
1945	7 717.7	154.2	.05005	315 310	2 880 933	3 196 243	20.728
1946	8 050.1	148.8	.05410	172 926	3 249 950	3 422 876	23.003
1947	8 539.0	144.0	.05930	285 594	2 383 970	2 669 568	18.539
1948	9 506.9	149.4	.06363	125 386	3 681 793	3 807 179	25.483

[a] Oil-meal equivalent obtained by following weighting: soybean, linseed, cottonseed, and peanut cake and meal, 1.00; tankage, meat scrap, and fish meal, 1.40; gluten feed and meal, 0.70; copra meal, 0.50; (*The Feed Situation*, Oct., 1949, p. 15).

[b] U. S. Bureau of Agricultural Economics, *Agricultural Outlook Charts*, 1950, p. 47.

[c] Computed by dividing total production of protein by grain-consuming animal units.

[d] *Feed Statistics*, 1949 (p. 13).

Table 8. — Prices and Production of Soybean Meal as Related to Prices and Production of All Protein Supplements; and Prices and Supplies of Soybean Oil (Plus Supply of Cottonseed Oil) as Related to Composite Price and Supplies of Four Edible Fats and Oils

Year beginning Oct. 1	Price of soybean meal as percentage of composite price of all protein supplements	Production of soybean meal as percentage of production of all protein supplements	Price of soybean oil as percentage of composite price of four edible fats and oils	Supplies of soybean and cottonseed oil as percentage of supplies of four edible fats and oils
	perct.	*perct.*	*perct.*	*perct.*
1929	....	....	46.50	31.40
1930	....	....	41.54	30.36
1931	....	....	32.58	32.95
1932	....	....	45.32	28.69
1933	....	....	48.23	27.52
1934	....	....	41.86	32.08
1935	99.7	13.5	38.83	36.07
1936	109.7	10.2	47.06	39.14
1937	102.0	13.3	37.43	44.86
1938	92.3	20.4	47.10	36.82
1939	94.2	24.7	36.53	34.64
1940	95.1	24.0	43.38	34.85
1941	99.1	27.4	58.68	34.47
1942	95.7	38.6	49.98	40.78
1943	101.0	40.4	51.35	35.84
1944	100.6	45.7	51.09	45.08
1945	101.2	49.7	47.22	47.52
1946	99.8	50.8	61.30	44.02
1947	101.9	44.9	63.43	48.01
1948	101.7	45.5	52.76	50.64

Table 9. — Value of Oil and Meal in a Bushel of Soybeans, and Actual and Estimated Marketing and Processing Margins, 1929-30 to 1948-49

Year beginning Oct. 1	Value of oil	Value of meal	Total value of oil and meal	Gross margin for marketing and processing per bushel of beans	
				Actual	Estimated by formula[a]
	cents	*cents*	*cents*		
1929	90.9	122.20	213.10	$.52	...
1930	63.3	78.86	142.16	.24	...
1931	34.4	50.51	84.91	.50	...
1932	46.0	65.89	111.89	.65	...
1933	58.6	80.85	139.45	.68	...
1934	77.6	82.74	160.34	.74	...
1935	74.2	69.50	143.70	.76	$.59
1936	90.6	98.48	189.08	.71	.68
1937	57.2	67.20	124.40	.44	.50
1938	48.3	63.00	111.30	.47	.45
1939	49.5	70.08	119.58	.43	.45
1940	70.4	73.94	144.34	.59	.49
1941	112.2	101.53	213.73	.60	.64
1942	117.5	103.79	221.29	.61	.64
1943	117.5	125.88	243.38	.63	.68
1944	117.5	126.10	243.60	.40	.66
1945	119.1	151.30	270.40	.64	.71
1946	228.6	196.67	425.27	1.73	1.07
1947	237.6	222.15	459.75	1.21	1.14
1948	131.0	185.25	316.25	.76	.76

[a] Using the formula 25 cents +25 percent of the value of the products (oil and meal) −2 cents for each year since 1934-35.

Table 10. — Residuals From Figs. (Charts) 2, 3, 4, 6, and 7, in Logarithms

Year beginning Oct. 1	Fig. 2	Fig. 3	Fig. 4	Fig. 6	Fig. 7
1929	.....	.....	.....	+.070	+.055
1930	.....	.....	.....	+.031	−.012
1931	.....	.....	.....	−.025	−.021
1932	.....	.....	.....	+.011	.....
1933	.....	.....	.....	+.051	.....
1934	.....	.....	.....	+.156	+.001
1935	+.050	+.017	−.001	+.135	+.001
1936	+.115	+.095	+.008	+.100	+.010
1937	.....	+.001	+.017	+.019	+.012
1938	+.002	−.022	−.011	−.062	−.071
1939	+.003	−.024	−.006	−.075	−.055
1940	−.060	−.057	−.041	−.062	−.008
1941	−.055	−.058	−.052	−.060	−.001
1942	−.127	−.120	−.134	−.089	+.041
1943	−.102	−.091	−.121	−.132	+.036
1944	−.135	−.113	−.118	−.160	−.079
1945	−.073	−.054	−.061	−.130	−.139
1946	+.005	+.038	−.059	+.005	+.057
1947	−.005	+.046	+.012	−.039	+.031
1948	−.100	−.036	+.015	−.231	−.053

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